

**NUVERA, CATERPILLAR,
WILLIAMS BIO- ENERGY**

**PEM Ethanol Fuel Cell -
Utility Interactive System**

**Presentation to
Department of Energy
30 Oct 2001
Washington, DC**

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Introduction

Program Contact Points

Funding and Budgeting

Program Plan

Technical Concept

Q&A and Discussions

PROGRAM PARTNERSHIP

NUVERA

- PEM Fuel Cell and Reformer
- Fuel Cell Control
- System Testing and Key System Variables Data Acquisition
 - ♦ Fuel Processor, Fuel Cell, Byproduct Management
 - ♦ Fuel Cell Control, System Control Interface

CATERPILLAR

- Program Management
- System Control
- System Testing and Data Acquisition
 - ♦ Inverter, Supporting Electronics
 - ♦ Electrical Power System Components

WILLIAMS BIO-ENERGY

- Ethanol Fuel Source
- System Test Facility
- System Test Monitoring
 - ♦ Power System Integration
 - ♦ Facility Resources



Program Contact Points

Principal Investigator

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NUVERA

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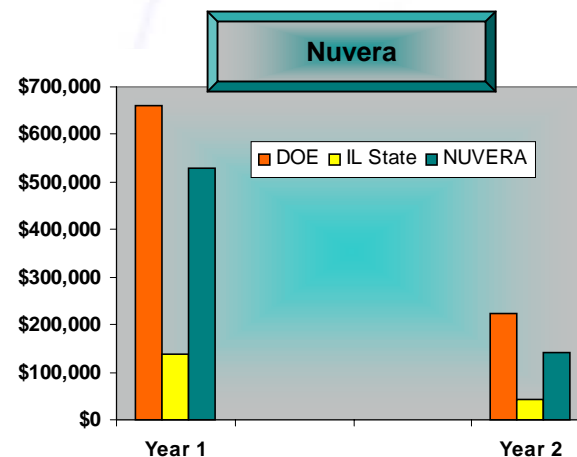
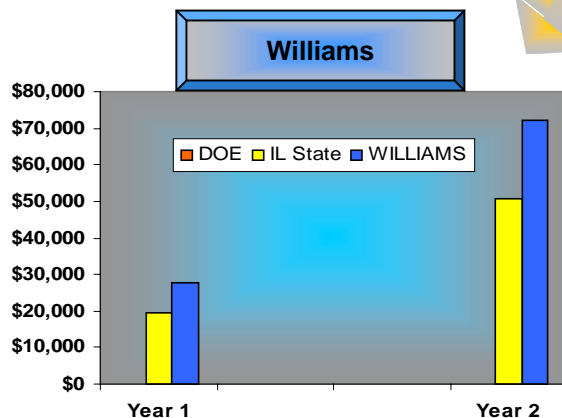
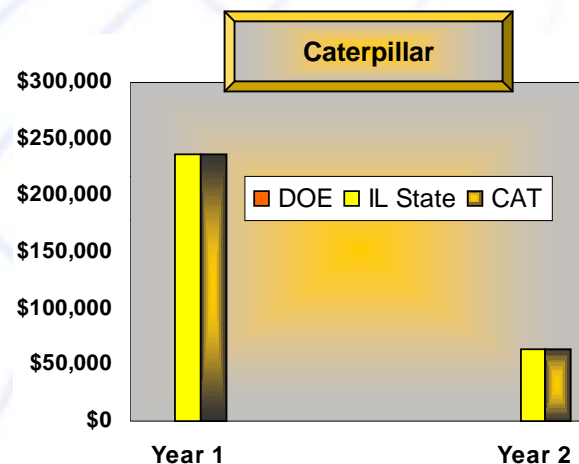
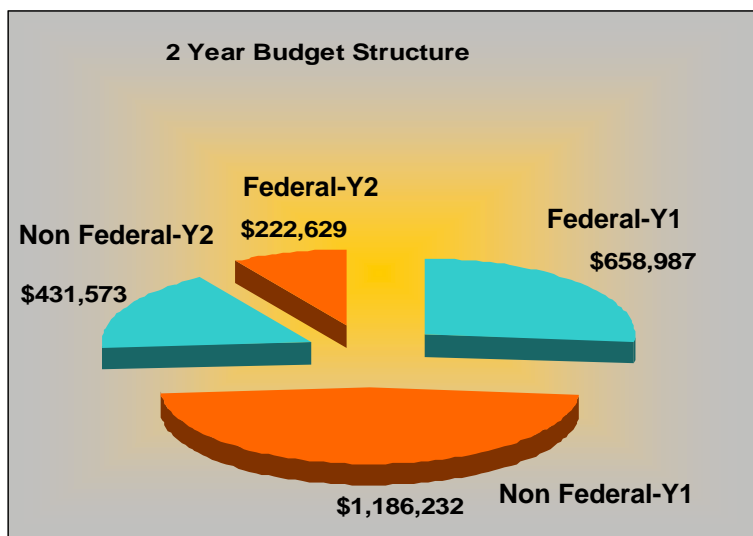
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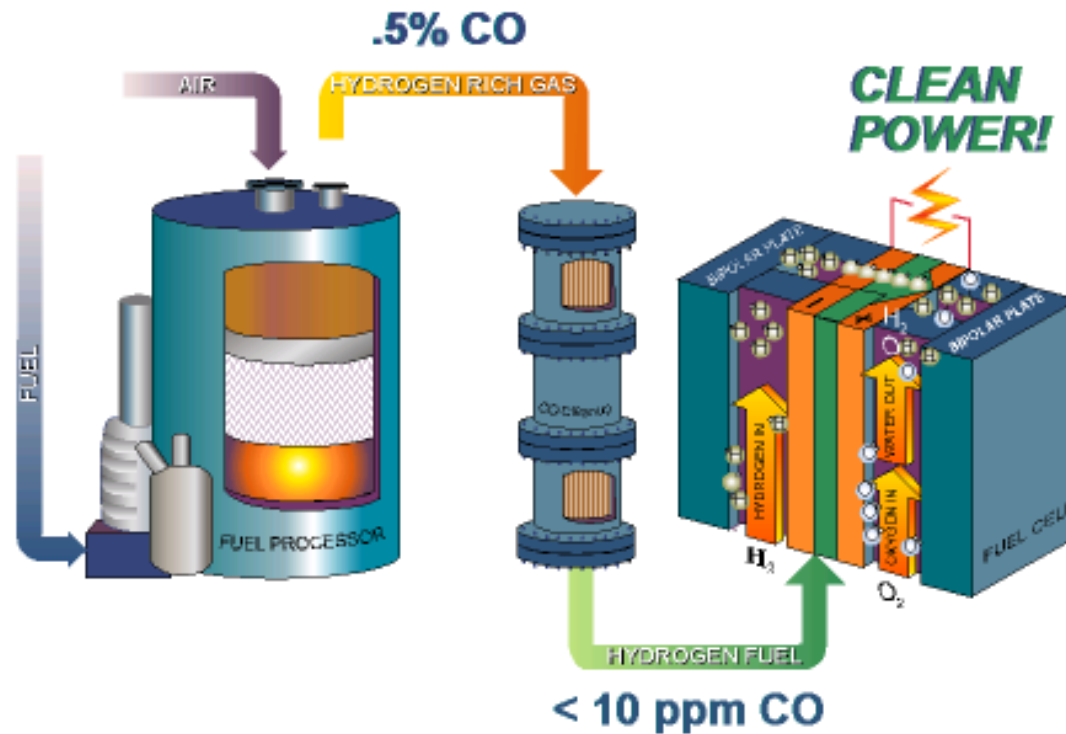
Estimated Funding Structure



Goals and Objectives

- **Demonstrate Performance and Durability**
- **Remove Technical Uncertainties**
- **Understand Correlation and Reduce Gaps between Stationary and Transportation Application**
- **Data Collection to Evaluate Economic Feasibility**
- **Assess Commercial Viability of Total System**

PEM Fuel Cell Power System

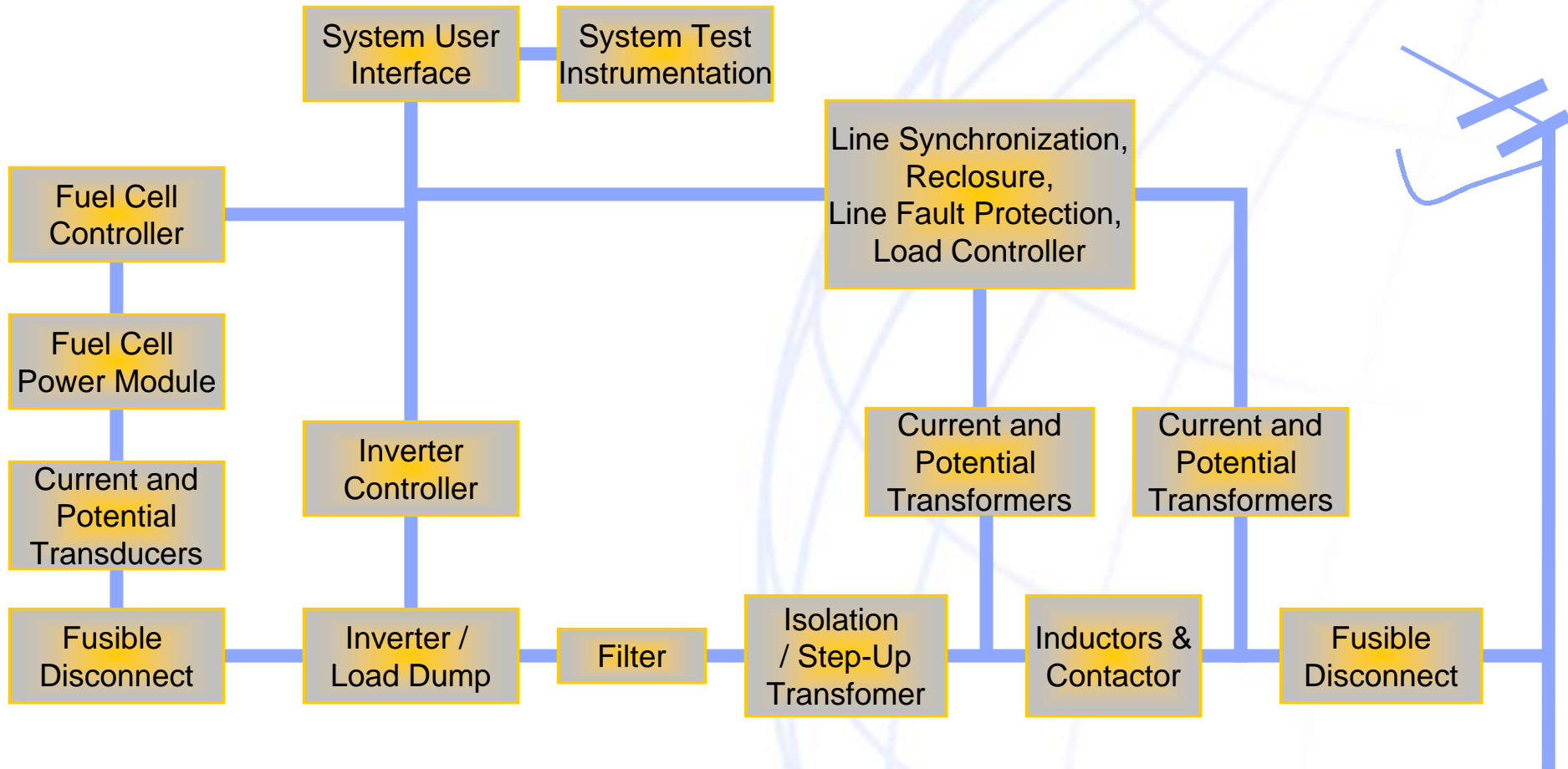


**Model "B"
Multi-fuel
Processor**

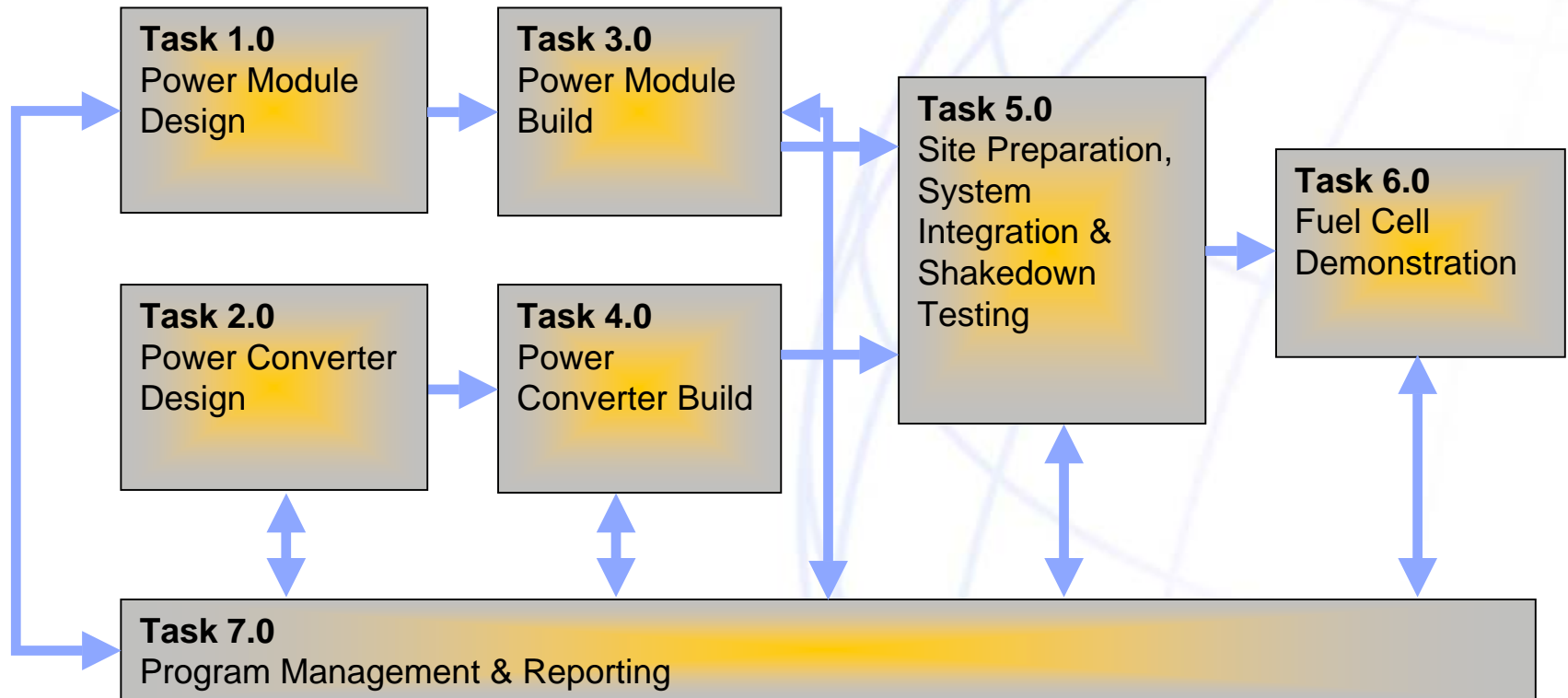
**CO Clean-Up
Device**

**Fuel Cell
Stack**

Power System and Control Integration: *Technical Concept*



Work Breakdown Structure



TASKS RESPONSIBILITIES

	NUVERA	WILLIAMS	CATERPILLAR
Task 1: Power Module Design			
Task 1.1: DC Power Module Design	●	◐	◐
Task 1.2: Fuel Processor Design	●		
Task 1.3: Fuel Stack Design	●		
Task 1.4: Air Management Design	●		
Task 1.5: Water Management Design	●		
Task 1.6: Thermal Management Design	●		
Task 2: Power Converter Design			●
Task 3: Power Module Build			
Task 3.1: Power Module Fabrication	●		
Task 3.2: Power Module Testing	●		
Task 4: Power Converter Build			●
Task 5: Site Preparation, System Integration & Shakedown Testing	◐	●	◐
Task 6: Fuel Cell Demonstration	●	◐	●
Task 7: Program Management & Reporting	◐	◐	●

Legend

- Primary Responsibility
- ◐ Joint Responsibility

PEM FUEL CELL POWER SYSTEM ON ETHANOL																												
Month -->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24				
Task 1.0 Power Module Design																												
	% - Specifications Established																											
Task 2.0 Power Converter Design																												
	% - Specifications Established																											
Task 3.0 Power Module Build																												
					% - Power Module Design Review																							
													% - Power Module Built & Bench Tested															
Task 4.0 Power Converter Build																												
					% - Power Converter Design Review																							
													% - Power Converter Built & Bench Tested															
Task 5.0 Site Preparation, System Integration & Shakedown Testing																												
													% - System Control Operational															
Task 6.0 Fuel Cell System Demonstration																												
																	% - 4000-hr Demo Underway											
																					4000-hr Demo Completed - %							
Task 7.0 Program Management & Reporting																												
- Management Summary, Project Status, Financial Status & Technical Progress Reports:													DOE Oral Annual Briefing - %								DOE Oral Final Briefing - %							
					%					%					%					%					%			
																								Final Technical Report - %				

Success and Opportunities

Technical Successes

- 4000 Hr Durability Testing:
 - Fuel Cell & Balance of Plant
 - Continuous 14kWe
 - No Faults/Downtime
- Low Emissions
- Efficiency:
 - System > 25%
 - Inverter > 93%
 - Reformer > 80%
 - Fuel Stack > 50%
- Development of Low Cost Critical Hardware
- Project Documentation, On Time Delivery, and Within Budget

Opportunities

- Development of PEM Fuel Cell Power / Utility Interactive System Integration Competency
- Demonstrate Ability of Partners to Deliver World Class Product
- Influence Direction of Future Enterprises in Fuel Cell / Utility Interactive Systems in Mobile and Stationary Applications
- Demonstrate System Feasibility in Cogeneration Applications, Hybrid, and Other Fuel Applications
- Minimize/Remove Technical Uncertainties and Enhance Learning Curve

